Transforming the Asian Motorbike City?

Evaluating the Travel Effects of the *Taipei Metro* Mass Rapid Transit System in Taiwan

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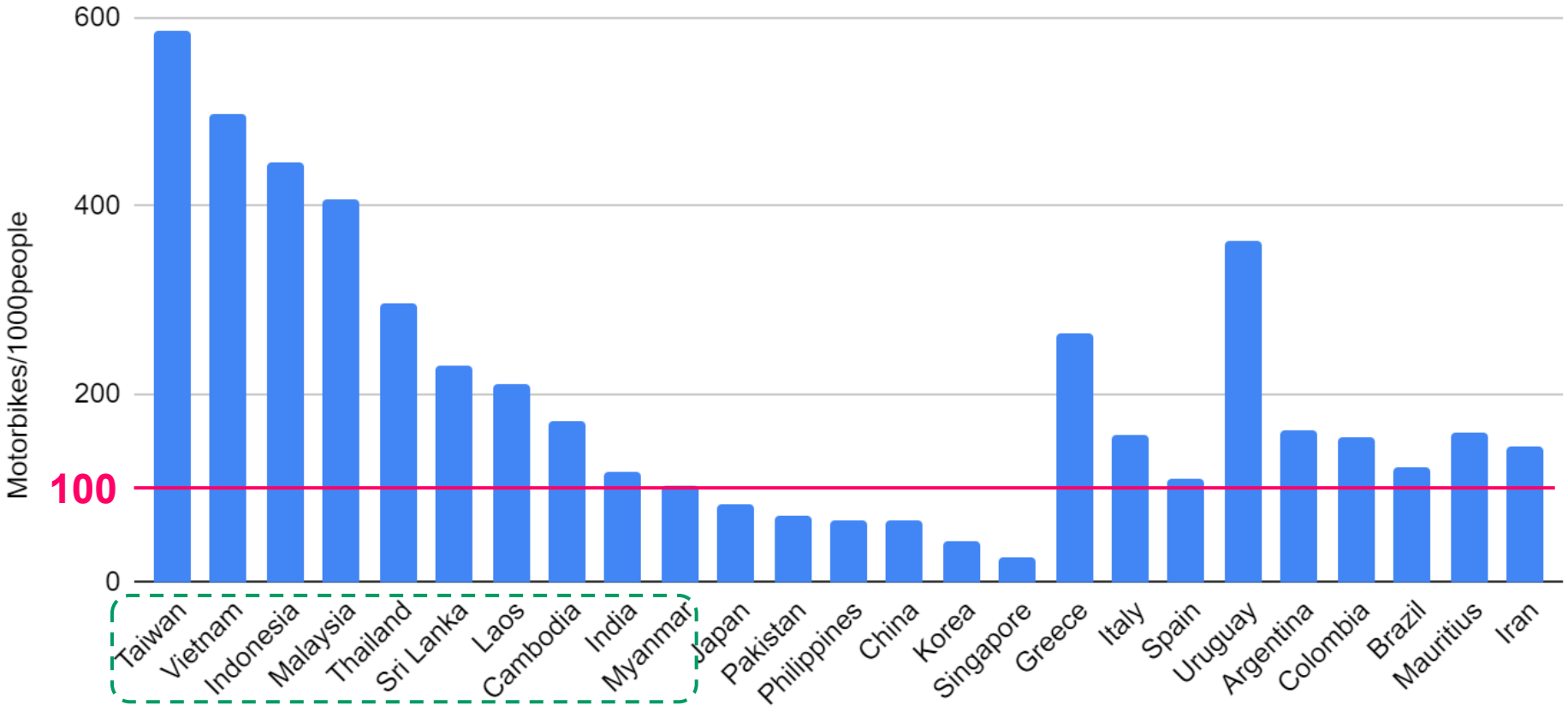
World's highest motorbike ownership

Taiwan and many Japan-aided (including in terms of transport planning) Asian countries



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Harm brought by motorbikes

Disproportionate environmental (air pollutants) and health (fatality rate) harm compared with cars

Photo by Richard Ricciardi (CC BY 2.0)

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Earliest motorbike city to adopt metro

Country	First metro inaugurated	City
India	1984*	Kolkata
Taiwan	**1996**	**Taipei**
Malaysia	1996	Kuala Lumpur
Thailand	1999	Bangkok
Indonesia	2019	Jakarta
Vietnam	2021	Hanoi

**Too early for mass motorbike ownership.*

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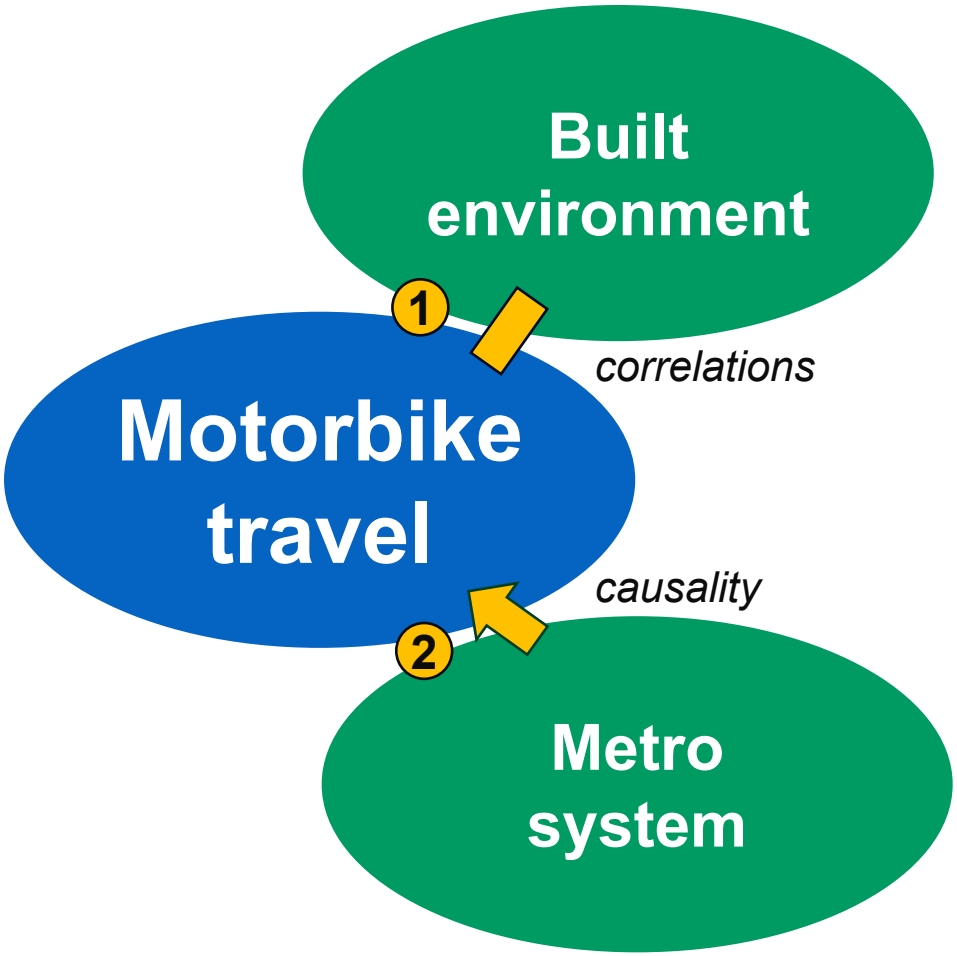
Two research questions

1. What is the relationship between the built environment and motorbike ownership level, mode choice likelihood, and amount of use?
2. Does the metro system influence motorbike mode choice likelihood and amount of use?



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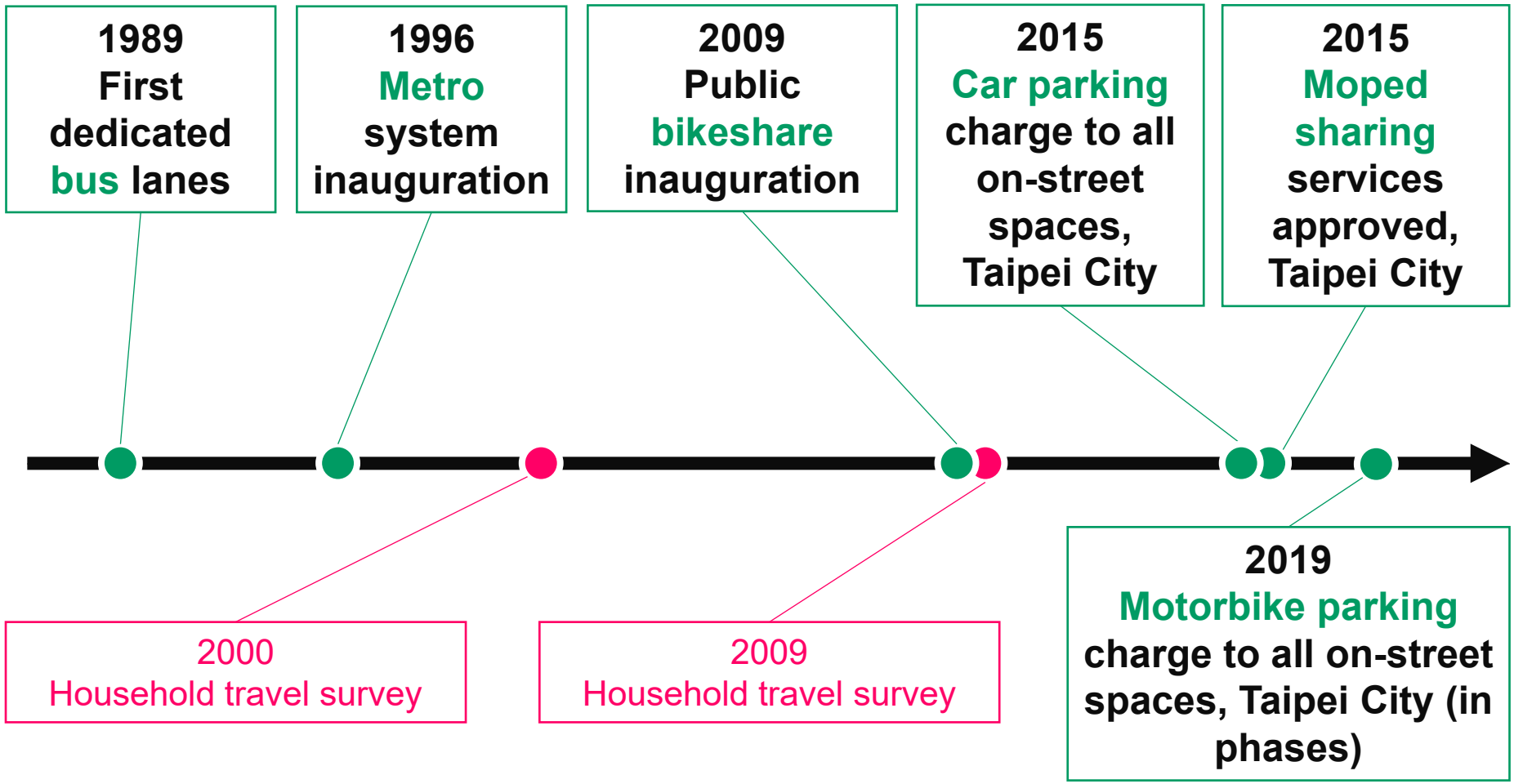
Transport policies & Trip data in Taipei



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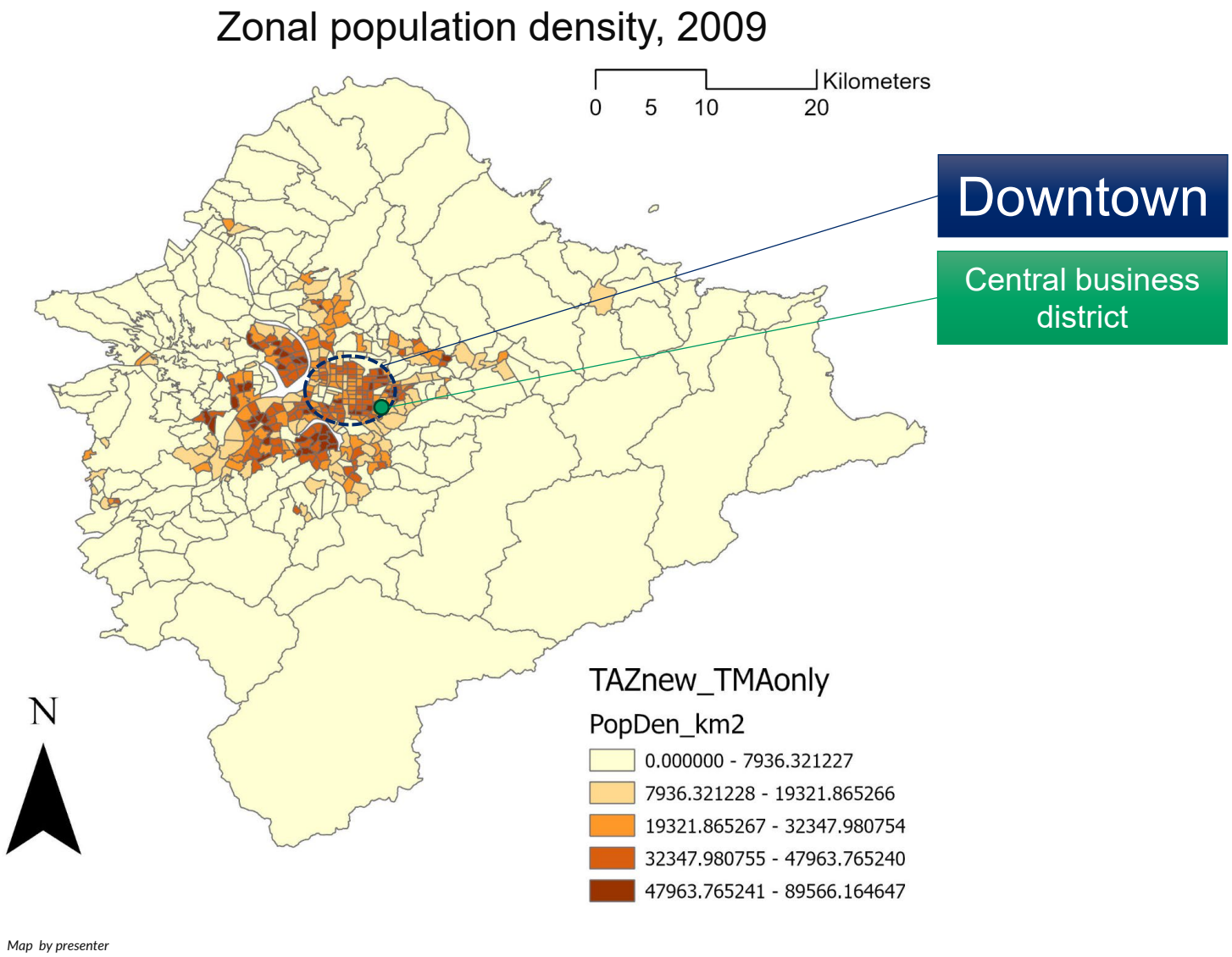
Crowded in both downtown & suburbs



Map by presenter

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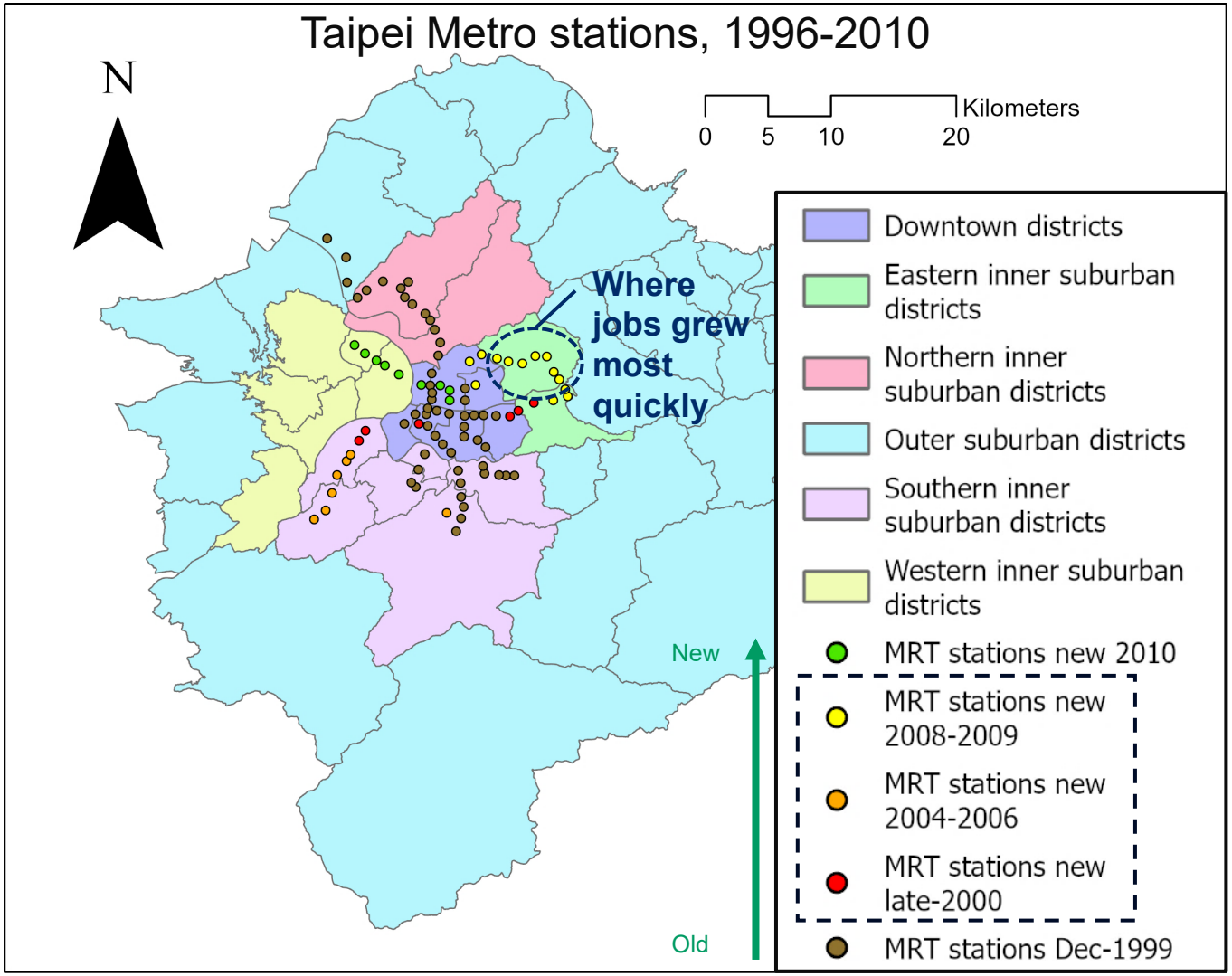
Disconnect between metro & jobs

Order of priority in expansions of the metro network, up to 2009



Map by presenter

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Faster growth of motorbikes than cars

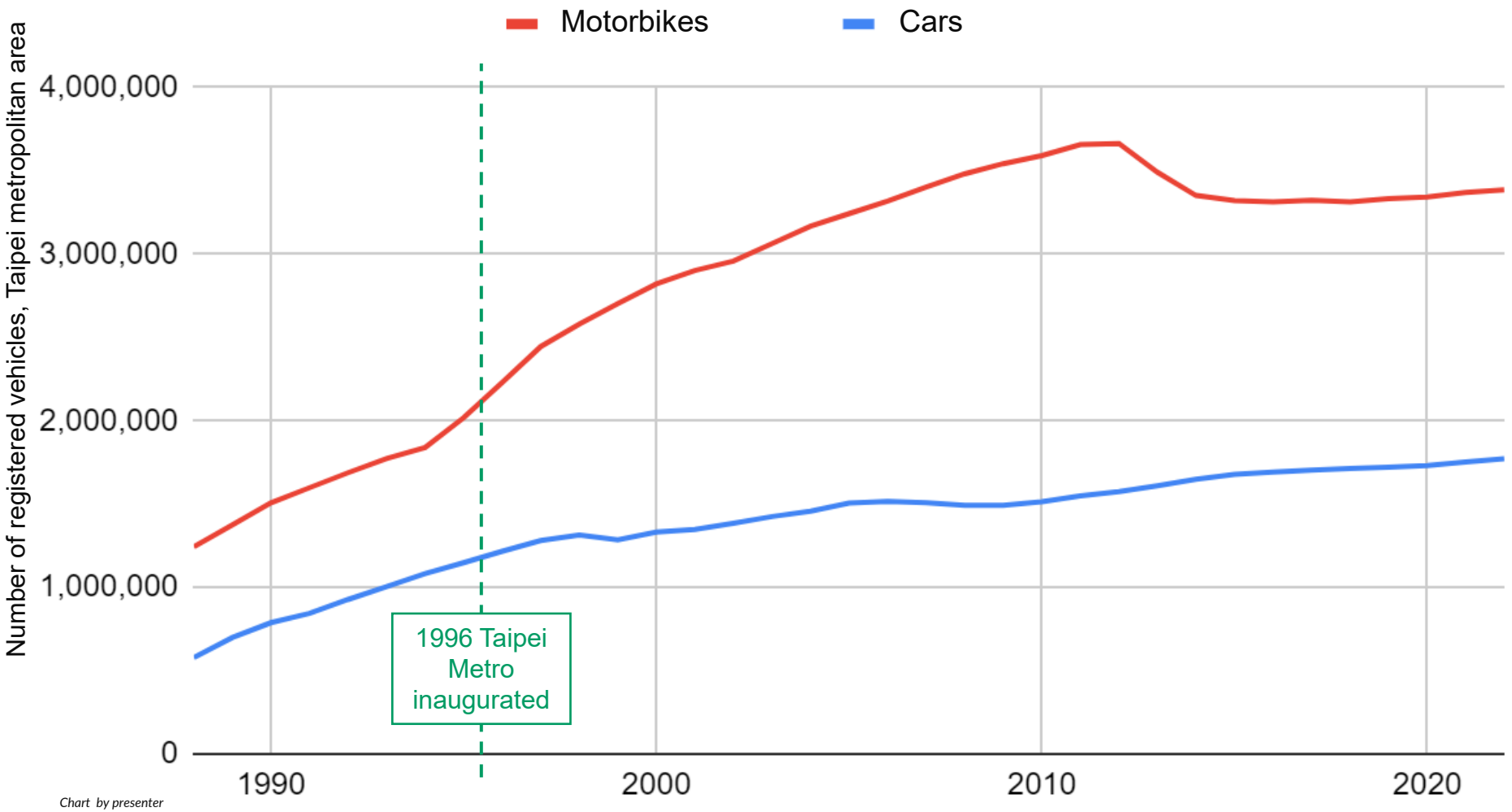

Chart by presenter

Source: Ministry of Transportation and Communications

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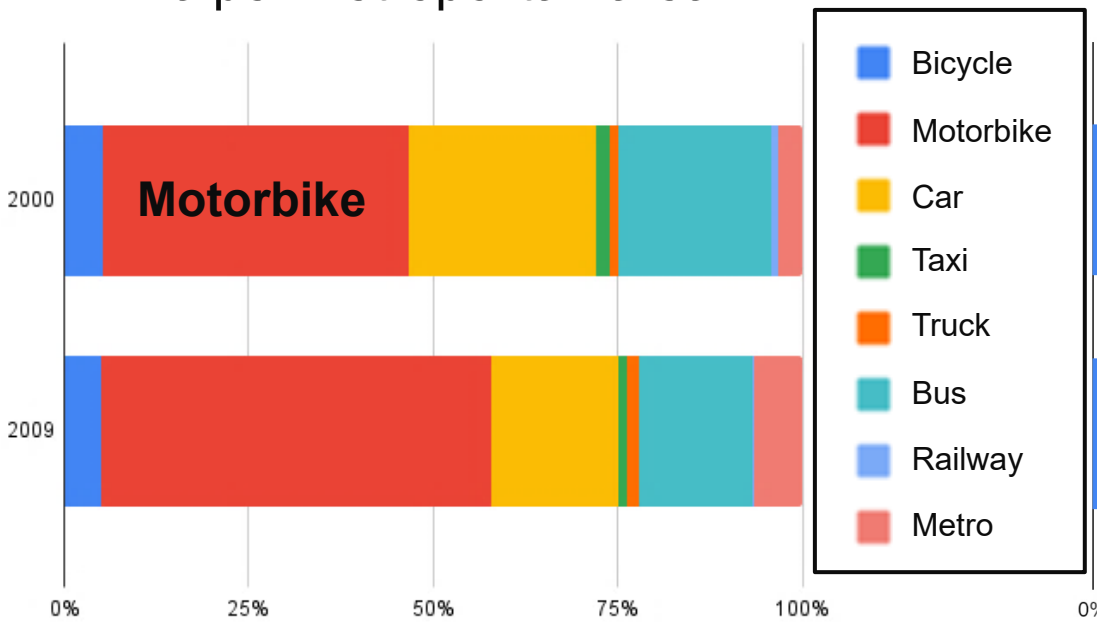
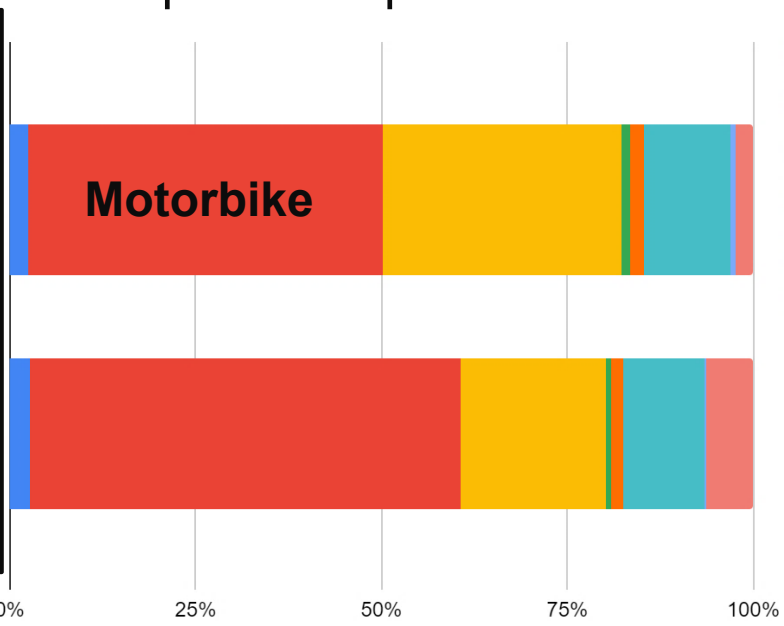
Increased modal share of motorbike

Shares of modes in all trips, Taipei metropolitan area



Shares of modes in trips to office, Taipei metropolitan area



Charts by presenter

Source: 2000 and 2009 household travel surveys of the Taipei metropolitan area

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Methodology

Objective: **To examine the relationships between the built environment*, income, and motorbike travel**.**

* Built environment (of the zone in which a household lived or a trip started) = population density, job density, land use diversity, distance to central business district, distance to metro stations

** Motorbike travel = motorbike ownership, mode choice, and use

Method: Using the household travel survey data*** to estimate two models (2000 & 2009) on each of the following three travel characteristics

-Household vehicle ownership (multinomial logit regression on 5 alternatives)

-Mode choice (multinomial logit regression on 5 alternatives)

-Household motorbike use (tobit regression)

*** 23,650 households and 84,614 trips in 2000 as well as 4,104 households and 8,618 trips in 2009

Household vehicle ownership models

Multinomial logistic regression on household vehicle ownership levels

0 motorcycles and 0 or 1 or more cars (base)	1 motorcycle and 0 cars		1 motorcycle and 1 or more cars		2 or more motorcycles and 0 cars		2 or more motorcycles and 1 or more cars	
	Coef. & SE 2000	Coef. & SE 2009	Coef. & SE 2000	Coef. & SE 2009	Coef. & SE 2000	Coef. & SE 2009	Coef. & SE 2000	Coef. & SE 2009
Population density (100,000 people/km²)	0.69	0.80	0.38	-0.64	1.16	0.67	0.62	0.64
	0.14 ***	0.36 *	0.12 **	0.32 *	0.15 ***	0.36 .	0.13 ***	0.32 *
Job density (100,000 jobs/km²)	-0.01	-0.05	0.03	-0.55	-0.09	-1.10	-0.35	-1.40
	0.12	0.25	0.10	0.24 *	0.13	0.31 ***	0.11 **	0.28 ***
Land use diversity index (0-1)	-0.002	0.02	0.19	0.24	0.10	0.16	0.21	-0.21
	0.15	0.34	0.13	0.29	0.16	0.34	0.13	0.30
Distance to the central business district (100 km)	3.40	0.53	5.87	4.14	8.43	3.24	7.34	3.99
	0.74 ***	1.54	0.63 ***	1.32 **	0.78 ***	1.50 *	0.66 ***	1.33 **
Whether household was located within 800 meters from a metro station (1/0)	-0.12	-0.17	-0.20	-0.22	-0.16	-0.32	-0.20	-0.34
	0.05 *	0.12	0.04 ***	0.10 *	0.06 **	0.12 **	0.05 ***	0.10 ***
Number of residents in household	0.10	0.06	0.34	0.35	0.56	0.49	0.71	0.67
	0.02 ***	0.05	0.02 ***	0.04 ***	0.02 ***	0.04 ***	0.02 ***	0.04 ***
Household income in 2nd lowest quintile (base: lowest quintile) (1/0)	0.29	0.68	1.07	1.05	0.67	0.84	0.87	1.08
	0.06 ***	0.16 ***	0.06 ***	0.17 ***	0.08 ***	0.19 ***	0.07 ***	0.20 ***
Household income in middle quintile (“) (1/0)	-0.08	0.39	1.21	1.31	0.68	1.03	1.14	1.58
	0.07	0.17 *	0.06 ***	0.17 ***	0.08 ***	0.19 ***	0.07 ***	0.19 ***
Household income in 2nd highest quintile (“) (1/0)	-0.76	-0.54	1.15	1.15	0.61	0.59	1.26	1.58
	0.07 ***	0.22 *	0.06 ***	0.19 ***	0.08 ***	0.21 **	0.07 ***	0.20 ***
Household income in highest quintile (“) (1/0)	-1.36	-0.88	0.79	0.98	-0.17	0.34	1.10	1.52
	0.10 ***	0.24 ***	0.07 ***	0.19 ***	0.09 .	0.22	0.07 ***	0.20 ***
Intercept	-1.01	-0.87	-2.33	-1.91	-3.93	-2.78	-4.02	-3.32
	0.13 ***	0.28 **	0.11 ***	0.26 ***	0.15 ***	0.30 ***	0.13 ***	0.28 ***
Number of observations (N=)	23650	4104	23650	4104	23650	4104	23650	4104
Log-Likelihood	-33662	-5899.7	-33662	-5899.7	-33662	-5899.7	-33662	-5899.7
Pseudo R-squared	0.0825	0.0827	0.0825	0.0827	0.0825	0.0827	0.0825	0.0827

Notes: (1) Coef. = Coefficient estimate; SE = standard error; (2) Significance codes: *** p < 0.001; ** p < 0.01; * p < 0.05; . p < 0.1; (3) The fraction of responses correctly predicted by each model was calculated: 0.2808 for the 2000 model, and 0.3772 for the 2009 model.

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Insights on motorbike ownership

Differences between 2000 and 2009

- Correlations between population density, job density, and the likelihood that a household owning 1 motorbike and 1 or more cars chooses to own additional motorbikes turned from positive in 2000 to negative in 2009.

Where motorbike ownership levels are likely to be greater:

- Higher population density, lower job density, being farther from the central business district and from metro stations are correlated with higher household motorbike ownership levels.

Car's substitution of motorbike:

- Car-owning households are less inclined to increase motorbike ownership than non-car-owning ones.
- Higher income is associated with a reduced likelihood of owning motorbikes but no cars.

Share of households	2000	2009
0 motorbikes and 0 or 1 or more cars	23%	19%
1 motorbike and 0 cars	13%	14%
1 motorbike and 1 or more cars	27%	24%
2 or more motorbikes and 0 cars	11%	14%
2 or more motorbikes and 1 or more cars	26%	29%

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Mode choice models

Multinomial logistic regression on mode choice likelihood of bus/car/metro/cycling relative to motorbike in a trip

Motorcycle (base)	Bicycle		Bus		Car		Metro	
	Coef. & SE 2000	Coef. & SE 2009	Coef. & SE 2000	Coef. & SE 2009	Coef. & SE 2000	Coef. & SE 2009	Coef. & SE 2000	Coef. & SE 2009
Population density (100,000 people/km²)	1.03	0.73	-0.73	-1.16	-0.96	-1.18	-1.73	-1.75
	0.11 ***	0.32 *	0.06 ***	0.19 ***	0.06 ***	0.22 ***	0.11 ***	0.27 ***
Job density (100,000 jobs/km²)	-0.53	-0.54	0.25	0.63	-0.27	0.01	-0.40	0.48
	0.12 ***	0.24 *	0.06 ***	0.11 ***	0.06 ***	0.13	0.10 ***	0.14 ***
Land use diversity index (0-1)	0.11	-0.27	0.28	0.35	0.11	-0.12	0.52	0.16
	0.11	0.29	0.06 ***	0.17 *	0.05 *	0.18	0.10 ***	0.21
Distance to the central business district (100 km)	-2.97	-3.21	-6.61	-1.06	-2.02	-2.21	-4.21	-7.20
	0.48 ***	1.52 *	0.27 ***	0.86	0.23 ***	0.98 *	0.55 ***	1.24 ***
Whether trip started within 800 meters from a metro station (1/0)	0.09	0.23	-0.02	0.16	0.09	0.30	2.06	2.09
	0.04 *	0.11 *	0.02	0.06 *	0.02 ***	0.07 ***	0.05 ***	0.13 ***
Number of residents in household	0.07	0.20	0.21	0.16	0.05	-0.04	0.43	-0.21
	0.03 *	0.09 *	0.02 ***	0.05 **	0.02 **	0.06	0.04 ***	0.07 **
Household income in 2nd lowest quintile (base: lowest quintile) (1/0)	-0.06	0.06	-0.20	-0.22	0.30	0.23	0.02	0.001
	0.06	0.19	0.03 ***	0.12 .	0.04 ***	0.17	0.07	0.17
Household income in middle quintile (“) (1/0)	-0.27	-0.03	0.08	-0.04	0.53	0.68	0.48	0.06
	0.07 ***	0.20	0.04 *	0.12	0.04 ***	0.17 ***	0.08 ***	0.17
Household income in 2nd highest quintile (“) (1/0)	-0.23	-0.19	0.26	0.23	0.87	0.92	1.08	0.04
	0.10 *	0.25	0.05 ***	0.14	0.05 ***	0.18 ***	0.10 ***	0.19
Household income in highest quintile (“) (1/0)	-0.37	-0.27	0.71	0.47	1.39	1.27	1.86	-0.19
	0.14 **	0.30	0.07 ***	0.17 **	0.07 ***	0.20 ***	0.14 ***	0.23
Age of trip maker	-0.14	-0.08	-0.18	-0.12	0.11	-0.002	-0.1	-0.06
	0.004 ***	0.01 ***	0.003 ***	0.01 ***	0.003 ***	0.01	0.005 ***	0.01 ***
(Age of trip maker)²	0.002	0.001	0.002	0.002	-0.001	0.0003	0.001	0.001
	0.00005 ***	0.0001 ***	0.00003 ***	0.0001 ***	0.00004 ***	0.0001 *	0.0001 ***	0.0001 ***
Male gender of trip maker (male=1, female=0)	-0.7	-0.71	-1.00	-1.08	0.61	0.40	-0.85	-0.86
	0.04 ***	0.10 ***	0.02 ***	0.06 ***	0.02 ***	0.07 ***	0.04 ***	0.08 ***
Residential self-selection bias correction	0.18	0.60	1.04	0.76	0.55	0.16	2.11	-0.40
	0.14	0.30 *	0.08 ***	0.17 ***	0.07 ***	0.19	0.16 ***	0.22 .
Intercept	0.32	-0.43	4.09	2.34	-2.92	-1.76	0.27	-0.70
	0.14 *	0.37	0.08 ***	0.22 ***	0.09 ***	0.28 ***	0.15 .	0.31 *
Number of observations (N=)	84614	8618	84614	8618	84614	8618	84614	8618
Log-Likelihood	-99728	-10763	-99728	-10763	-99728	-10763	-99728	-10763
Pseudo R-squared	0.1113	0.0833	0.1113	0.0833	0.1113	0.0833	0.1113	0.0833

Notes: (1) Coef. = coefficient estimate; SE = standard error; (2) Significance codes: *** p < 0.001; ** p < 0.01; * p < 0.05; . p < 0.1. (3) Other modes were excluded from modeling due to small modal shares; (4) The fraction of responses correctly predicted by each model was calculated (using the bicycle as base category instead): 0.4599 for the 2000 model, and 0.4901 for the 2009 model.

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Insights on motorbike mode choice

Differences between 2000 and 2009

- Correlation between job density and the mode choice likelihood of the car or the metro versus the motorbike turned from negative in 2000 to positive in 2009.
- Correlation between land use diversity index and the mode choice likelihood of the car or the bicycle versus the motorbike turned from positive in 2000 to negative in 2009.
- Correlation between the number of household members and the mode choice likelihood of the car or the metro versus the motorbike turned from positive in 2000 to negative in 2009.

Where motorbike mode choice is more likely:

- Higher population density, being farther from the central business district and from metro stations are correlated with higher mode choice likelihood for the motorbike.

What is most associated with motorbike-to-metro modal shift:

- Population density and distance to metro stations are most strongly associated with the motorbike's substitution with the metro than any other modes.

Motorbike travel as an inferior good:

- Income is negatively correlated with motorbike mode choice as the likelihood of choosing the buses, the car, and the metro instead of a motorbike generally rises with income.

Modal share	2000	2009
Motorbike	43%	47%
Bus	23%	22%
Car	25%	15%
Metro	4%	11%
Bicycle	4%	5%

Household motorbike use models

Left-censored tobit regression on the natural log of "one plus vehicle kilometers traveled" of all motorbike trips made by a household within a day

	Coefficient estimate & Standard error		Coefficient estimate & Standard error	
	2000		2009	
Population density (100,000 people/km²)	0.51	(0.11) ***	0.83	(0.29)**
Job density (100,000 jobs/km²)	-0.02	(0.11) ***	-1.73	(0.26)***
Land use diversity index (0-1)	0.45	(0.12) ***	-0.24	(0.25)
Distance to the central business district (100 km)	6.94	(0.55) ***	8.52	(1.22)***
Whether household was located within 800 meters from a metro station (1/0)	-0.24	(0.05) ***	-0.35	(0.12)**
Number of residents in household	0.49	(0.05) ***	0.47	(0.12)***
Household income in 2nd lowest quintile (base: lowest quintile) (1/0)	0.62	(0.06) ***	1.01	(0.16)***
Household income in middle quintile (") (1/0)	0.81	(0.08) ***	1.09	(0.18)***
Household income in 2nd highest quintile (") (1/0)	1.03	(0.12) ***	1.14	(0.25)***
Household income in highest quintile (") (1/0)	0.98	(0.18) ***	1.25	(0.33)***
Residential self-selection bias correction	0.98	(0.20) ***	0.50	(0.44)
Log(scale)	0.91	(0.01) ***	0.90	(0.02)***
Intercept	-0.94	(0.13) ***	-1.03	(0.33)**
Number of observations (N=)	23649		4104	
Log-Likelihood	-38640		-7089	
Pseudo R-squared	0.0137		0.0283	

Notes: (1) Standard errors between brackets. (2) Significance codes: *** p < 0.001; ** p < 0.01; * p < 0.05; . p < 0.1.

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Insights on motorbike use

Where motorbike use amount is likely to be greater:

- Higher population density, lower job density, being farther from the central business district and from metro stations, and higher income are correlated with higher household motorbike use amount.

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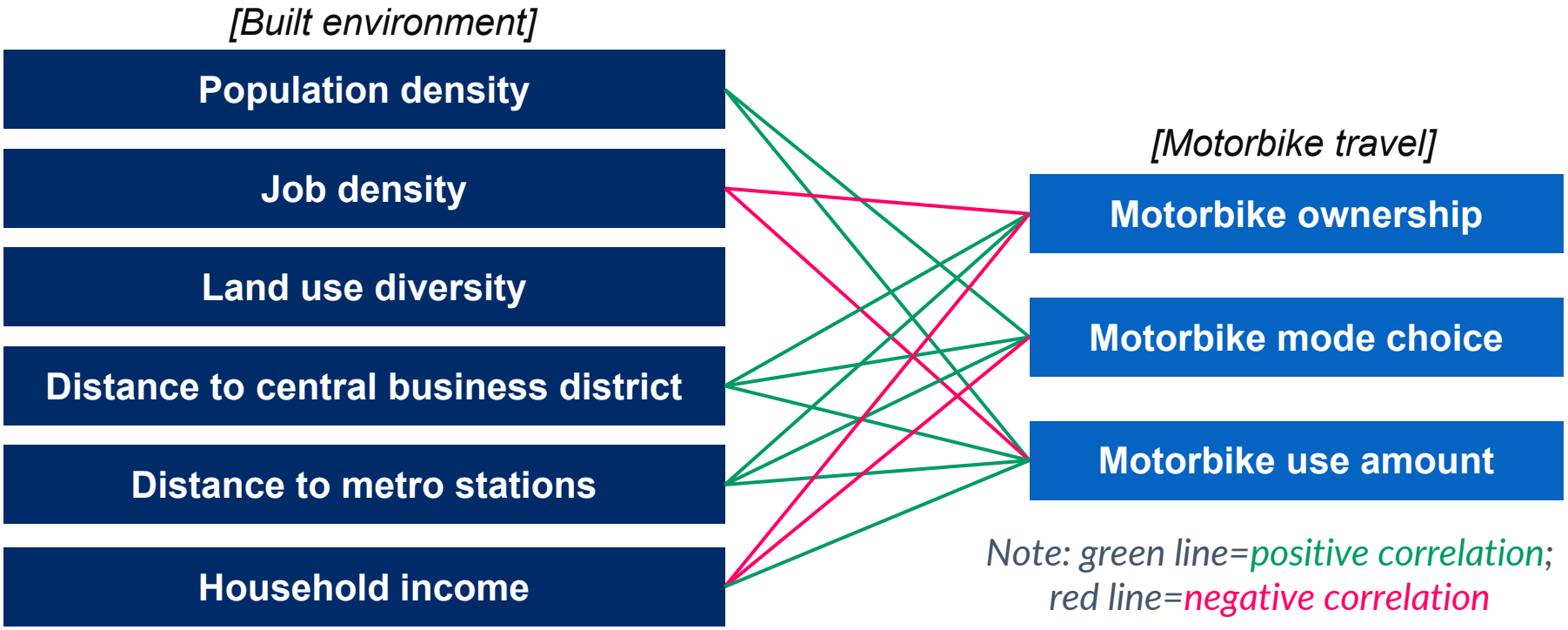
Summary: Relationship between built environment and motorbike travel

Motorbike travel is correlated with high population density, low job density, long distance from the central business district, and long distance from metro stations.



*The relationships are correlations, which are not necessarily causal.

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Elasticity estimates: Relationship between built environment and motorbike travel

Elasticity estimates of change in motorbike travel variables (base: model-predicted means) relative to changes in the built environment

		If population density in all TAZs is raised by 10%	If job density in all TAZs is raised by 10%	If land use diversity index in all TAZs is raised by 10%
Weighted average of household motorbike ownership	2000	0.05	-0.01	0.02
"	2009	0.05	-0.04	-0.02
Modal share of motorbike	2000	0.11	0.01	-0.06
"	2009	0.14	-0.04	-0.03
Household motorbike VKT	2000	0.20	-0.01	0.35
"	2009	0.21	-0.23	-0.10

Notes: (1) Coef. = Coefficient estimate; Std.error = standard error. (2) Significance codes: *** p < 0.001; ** p < 0.01; * p < 0.05; . p < 0.1.

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What would happen to motorbike travel if the built environment changed

An overall 10% increase in population density is associated with a 0.5% rise in the weighted average of household motorbike ownership, a rise >1% in the modal share of the motorbike, and a 2% rise in household motorbike use.

An overall 10% increase in job density is associated with a drop in the weighted average of household motorbike ownership and in household motorbike use.

An overall increase in land use diversity index is associated with a fall in motorbike mode choice likelihood.

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Summary of key findings: Built environment & motorbikes

What is the relationship between the built environment and motorbike ownership level, mode choice likelihood, and amount of use?

Motorbike travel is correlated with long distance from the central business district and long distance from metro stations.	Lower income is correlated with a higher likelihood of owning motorbikes but no cars.	Motorbike travel is correlated with low job density.	**Motorbike travel is correlated with high population density.**

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Population density & parking concerns

High population density may result in a preference for motorbikes over cars due to the relative ease of parking (even with parking violations)

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Methodology

Objective: **To examine the effects of the existence or introduction of older and new metro stations* on motorbike mode choice and use by comparing zones that are close** to these stations and zones not close to any stations, controlling for the built environment and income.**

* Metro stations = pre-2000 older stations, and new stations introduced between 2000 and 2009

** Close = within 800 meters.

Method: Pooling the travel survey data of 2000 and 2009*** as one dataset to estimate the following two types of models in which the difference-in-differences technique is used to estimate the effects of the metro stations

-Mode choice (ordinary least squares regression on 4 pairs of alternatives, each contains motorbike and a different mode)

-Household motorbike use (tobit regression)

*** 23,650 households and 84,614 trips in 2000 as well as 4,104 households and 8,618 trips in 2009

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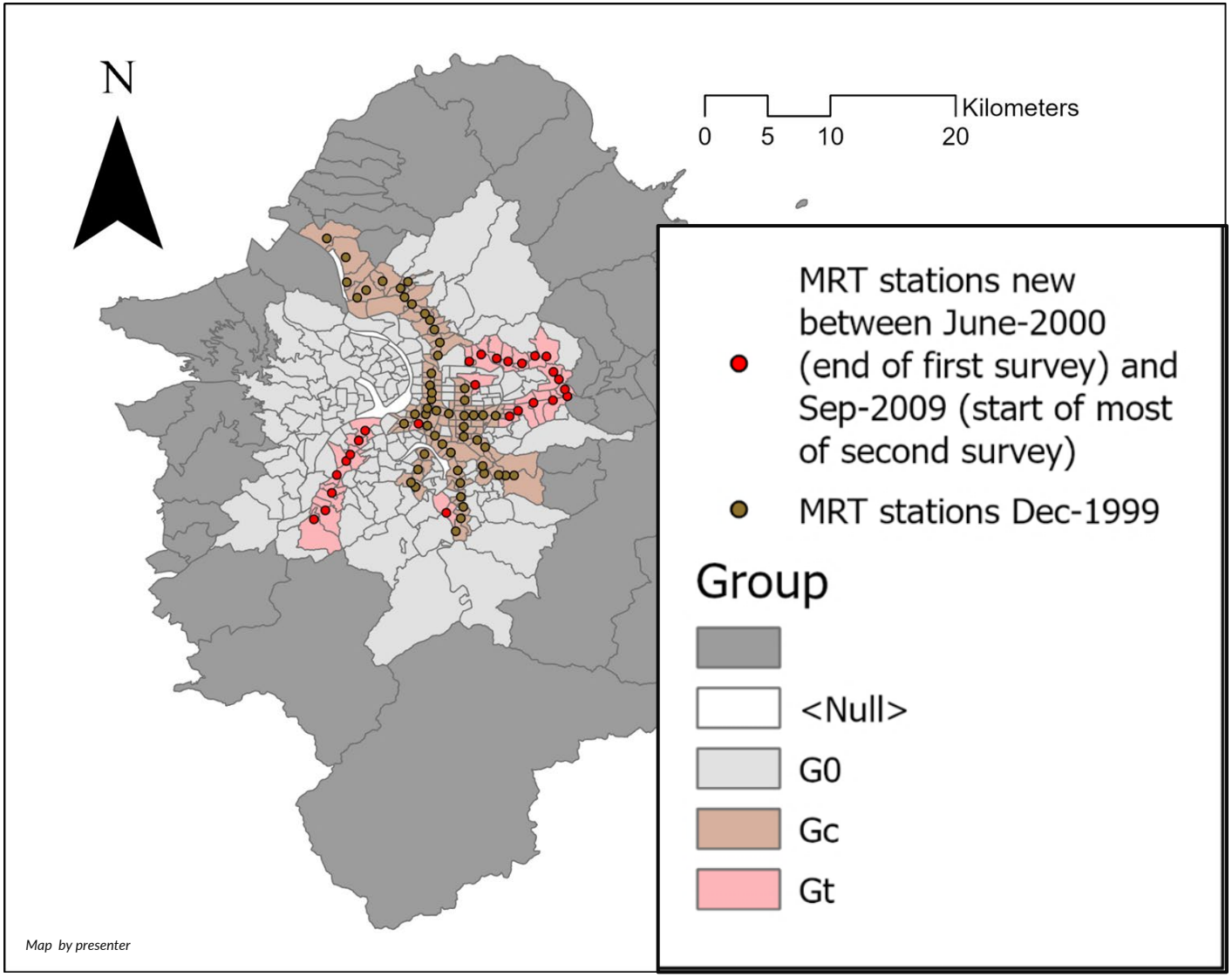
Two groups of metro stations: pre-2000 & introduced 2000-2009

2000 Household travel survey | 2009 Household travel survey



G0: zones not within 800m from any stations

Gc: zones within 800m from pre-2000 stations ("**older stations**")

Gt: zones within 800m from stations introduced 2000-2009 ("**new stations**")

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Metro's mode choice effect models

Model results of ordinary least squares regression on pairwise mode choice probability with the treatment effect of proximity to newly introduced and older pre-existing metro stations identified by difference-in-differences estimation

	Motorbike (1) vs. Bus (0)		Motorbike (1) vs. Car (0)		Motorbike (1) vs. Metro (0)		Motorbike (1) vs. Bicycle (0)	
	Coef.	Std.error	Coef.	Std.error	Coef.	Std.error	Coef.	Std.error
Time effect	0.04	0.01 ***	0.12	0.01 ***	-0.01	0.01 .	0.004	0.01
Treatment effect, new stations	-0.003	0.02	-0.05	0.02 *	-0.14	0.01 ***	0.01	0.01
Treatment effect, older stations	-0.01	0.01	0.0006	0.01	-0.07	0.01 ***	-0.02	0.01 .
Group effect, new stations	-0.01	0.01	-0.04	0.01 ***	0.01	0.005 **	0.01	0.005
Group effect, older stations	-0.02	0.005 ***	-0.03	0.005 ***	-0.16	0.004 ***	-0.01	0.004 ***
Population density (100,000 people/km^2)	0.17	0.01 ***	0.21	0.01 ***	0.14	0.01 ***	-0.08	0.01 ***
Job density (100,000 jobs/km^2)	-0.04	0.01 ***	0.03	0.01 **	0.01	0.01	0.05	0.01 ***
Land use diversity index (0-1)	-0.06	0.01 ***	0.01	0.01	-0.03	0.01 **	-0.01	0.01
Distance to CBD (100 km)	1.26	0.05 ***	0.41	0.05 ***	0.31	0.04 ***	0.27	0.04 ***
Household size	-0.01	0.05 ***	-0.01	0.004 **	-0.01	0.003 ***	0.01	0.003 *
Household income in 2nd quintile (base: lowest quintile) (1/0)	0.13	0.01 ***	-0.07	0.01 ***	0.01	0.01 *	0.04	0.005 ***
" in 3rd quintile (") (1/0)	0.10	0.01 ***	-0.12	0.01 ***	-0.004	0.01	0.07	0.01 ***
" in 4th quintile (") (1/0)	0.10	0.01 ***	-0.20	0.01 ***	-0.03	0.01 ***	0.08	0.01 ***
" in the highest quintile (") (1/0)	0.04	0.01 **	-0.31	0.01 ***	-0.06	0.01 ***	0.10	0.01 ***
Age of trip maker	0.004	0.0002 ***	-0.01	0.0002 ***	0.001	0.0002 ***	-0.0002	0.0001
(Age of trip maker)^2	-0.00003	0.000001 ***	0.00002	0.000002 ***	-0.000005	0.000001 ***	-0.00001	0.000001 ***
Male gender of trip maker (1/0)	0.18	0.004 ***	-0.11	0.004 ***	0.07	0.003 ***	0.05	0.003 ***
Self-selection bias correction	-0.10	0.01 ***	-0.12	0.01 ***	-0.07	0.01 ***	0.02	0.01 *
Intercept	0.17	0.01 ***	0.84	0.01 ***	0.79	0.01 ***	0.86	0.01 ***
Number of observations (N=)	61574		62951		44907		44335	
Log-Likelihood	-38971		-40656		-7780		-7721	
Adjusted R-squared	0.0838		0.0769		0.1205		0.0233	

Notes: (1) Coef. = Coefficient estimate; Std.error = standard error. (2) Significance codes: *** p < 0.001; ** p < 0.01; * p < 0.05; . p < 0.1.

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Insights on metro's effects on motorbike mode choice probability

New and older metro stations reduced the motorbike mode choice probability relative to the metro for trips originating within 800 meters by 1400% and 700% when compared with areas not close to any stations.

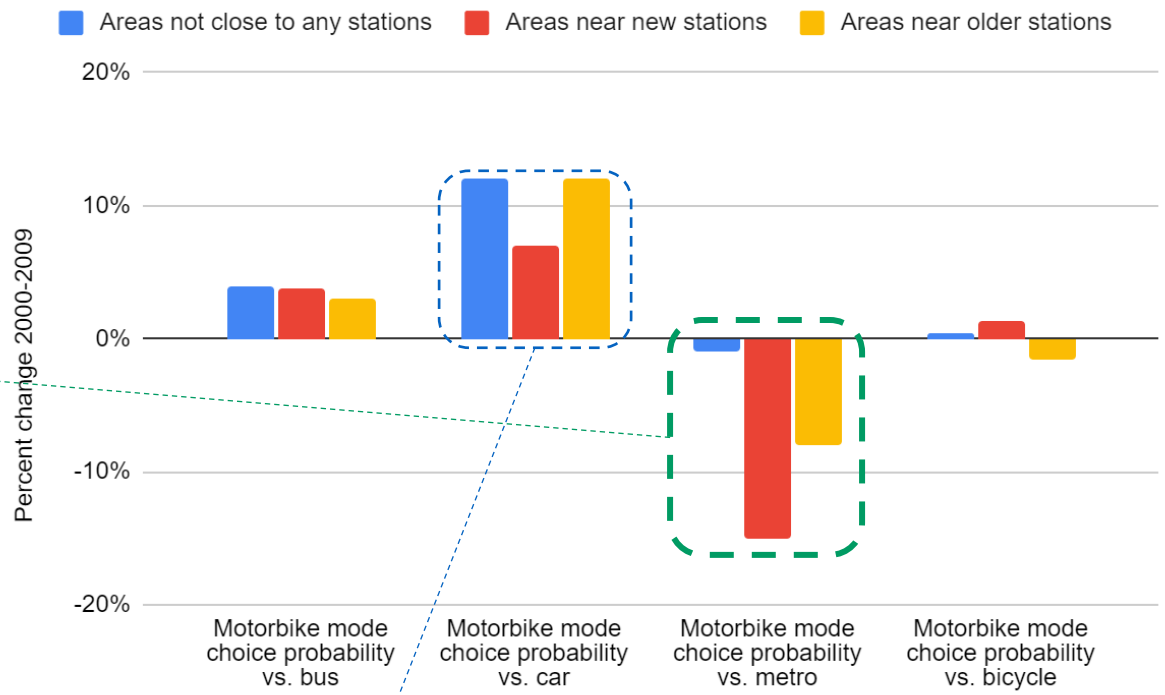

Chart by presenter

New metro stations reduced the motorbike mode choice probability relative to the car for trips originating within 800 meters by 72% when compared with areas not close to any stations.

**The relationships are causal, inferred with at least 95% level of confidence.*

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Metro's motorbike use effect model

Model results of left-censored tobit regression on the natural log of "one plus household motorbike vehicle kilometers traveled (VKT)", with the treatment effect of proximity to newly introduced and older pre-existing metro stations identified by difference-in-differences estimation

	Household motorbike VKT	
	Coefficient estimate	Standard error
Time effect	0.49	0.07 ***
Treatment effect, new stations	-0.29	0.15 .
Treatment effect, older stations	-0.24	0.10 *
Group effect, new stations	-0.14	0.06 *
Group effect, older stations	-0.14	0.05 **
Population density (100,000 people/km^2)	0.48	0.10 ***
Job density (100,000 jobs/km^2)	-0.22	0.09 *
Land use diversity index (0-1)	0.19	0.11 .
Distance to CBD (100 km)	6.92	0.49 ***
Household size	0.39	0.04 ***
Household income in 2nd quintile (base: lowest quintile) (1/0)	0.60	0.06 ***
" in 3rd quintile (") (1/0)	0.69	0.07 ***
" in 4th quintile (") (1/0)	0.79	0.1 ***
" in the highest quintile (") (1/0)	0.64	0.14 ***
Age of trip maker	--	--
(Age of trip maker)^2	--	--
Male gender of trip maker (1/0)	--	--
Self-selection bias correction	0.46	0.16 **
Log(scale)	0.91	0.01 ***
Intercept	-1.11	0.11 ***
Number of observations (N=)	27753	
Log-Likelihood	-45790	
Pseudo R-squared	0.0159	

Notes: Significance codes: *** p < 0.001; ** p < 0.01; * p < 0.05; . p < 0.1.

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Insights on metro's effects on household motorbike use amount

New and older metro stations reduced household motorbike use within 800 meters by 65% and 56% when compared with areas not close to any stations.

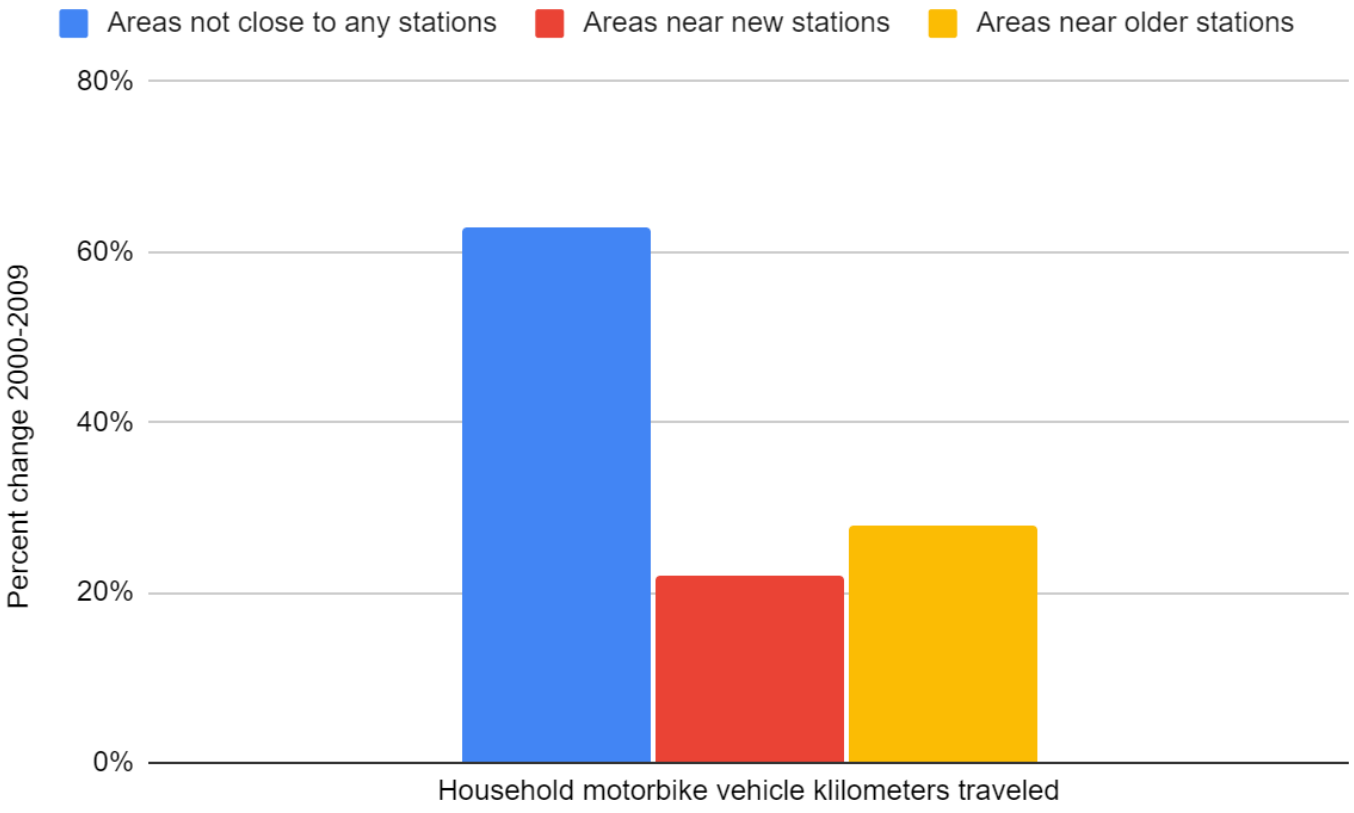

Chart by presenter

**The relationships are causal, inferred with at least 90% level of confidence.*

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Scenario simulation: Metro's effects on motorbike travel

Scenario simulation of percent change in dependent variables in scenarios of built environment and transit supply changes

		2000			2009		
		Actual, or model-predicted mean*	If metro's 800-meter zones cover 0% of surveyed households	If metro's 800-meter zones cover 100% of surveyed households	Actual, or model-predicted mean*	If metro's 800-meter zones cover 0% of surveyed households	If metro's 800-meter zones cover 100% of surveyed households
Modal shares	Motorbike	42.66%	44.30%	39.90%	47.37%	54.57%	43.40%
	Bicycle	4.38%	4.41%	4.35%	5.19%	5.24%	5.18%
	Bus	23.06%	24.44%	21.34%	21.86%	23.47%	21.06%
	Car	25.40%	25.53%	25.31%	14.90%	14.28%	15.28%
	Metro	4.50%	1.32%	9.10%	10.69%	2.45%	15.08%
Household motorbike VKT		0.71	0.83	0.60	1.14	1.33	0.97

Note: Actual means of household motorbike VKT were much larger than tobit model-predicted means.

Reference:
Chiu, B.-y. (2023). Does Mass Rapid Transit Reduce Motorcycle Travel? Evidence from Taipei, Taiwan. Transportation Research Part D: Transport and Environment. (Accepted)

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What would happen to motorbike travel if metro network further expanded

If the metro system fully covers all the surveyed households with its 800-meter zones, the modal share of the motorbike will be reduced by 3-4 percentage points and household motorbike use amount will be reduced by about 15%, compared with actual situations.

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Summary of key findings: metro & motorbikes

Does the metro system influence motorbike mode choice likelihood and amount of use?

Both new and older metro stations reduced the motorbike mode choice probability relative to the metro for trips starting nearby and household motorbike use nearby.

New metro stations reduced the motorbike mode choice probability relative to the car for trips starting nearby.

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New metro stations & gentrification

Introduction of new metro stations may result in **gentrification** (influx of higher-income residents) and **relative decrease of motorbikes compared with cars**

	Households in zones near no stations	Households in zones near new stations	Households in zones near older stations
	2000-2009 percentage change	2000-2009 percentage change	2000-2009 percentage change
Average income (quintile)	+1.74%	+2.75%	+3.55%
Average car ownership	-9.09%	-13.25%	-5.19%
Average motorbike ownership	+12.23%	+0.29%	+12.30%

	Trips from zones near no stations	Trips from zones near new stations	Trips from zones near older stations
	Percentage difference	Percentage difference	Percentage difference
Motorbike	+8.33%	+4.43%	+4.86%
Car	-11.02%	-8.69%	-10.48%
Metro	+0.95%	+9.13%	+7.04%

Source: 2000 and 2009 household travel surveys of the Taipei metropolitan area

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Conclusion: Built environment & motorbikes

What is the relationship between the built environment and motorbike ownership level, mode choice likelihood, and amount of use?

Motorbike travel is correlated with high population density, low job density, long distance from the central business district, and long distance from metro stations.

An overall 10% increase in population density is associated with a 0.5% rise in the weighted average of household motorbike ownership, a rise >1% in the modal share of the motorbike, and a 2% rise in household motorbike use.

An overall 10% increase in job density is associated with a drop in the weighted average of household motorbike ownership and in household motorbike use.

An overall increase in land use diversity index is associated with a fall in motorbike mode choice likelihood.

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Conclusion: Metro & motorbikes

Does the metro system influence motorbike mode choice likelihood and amount of use?

Yes. **The metro reduced motorbike travel around stations.**

New and older metro stations reduced the motorbike mode choice probability relative to the metro for trips originating within 800 meters by 1400% and 700% when compared with areas not close to any stations.

New and older metro stations reduced household motorbike use within 800 meters by 65% and 56% when compared with areas not close to any stations.

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Policy recommendations

Transit-oriented development (TOD)

Expand the metro

Photo by weichen_kh (CC BY-NC-ND 2.0)

Improve intermodal connections with the metro

Photo by presenter

Concentrate population and jobs toward metro stations (especially suburban ones)

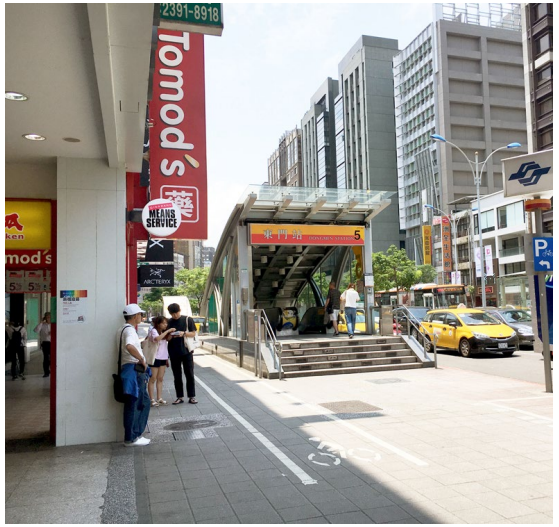

Photo by presenter

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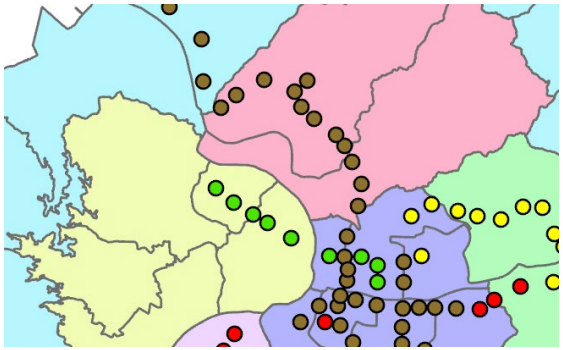
Areas for future research

Further refined research design for the current 2000 and 2009 data

- Disaggregating data
  - By trip purpose
  - By job type
- Adding treatment groups
  - Zones close to stations introduced after 2009



Map by presenter

Determinants of mode choice between motorbike and public transport

Photo by Richard Ricciardi (CC BY 2.0)

Post-2009 data (once available) for evaluating new transport policies' impacts

- Bikeshare, 2009-
- Moped sharing, 2015-
- By-the-hour motorbike on-street parking charge, 2019-

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Thank you

Questions or comments are welcome

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*This research has evolved from the presenter's PhD dissertation completed at the Department of City and Regional Planning at the University of Pennsylvania, USA, into its current form since he joined the Japan Transport and Tourism Research Institute in June 2023.

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